Bacteria TMDL Development for the Rappahannock River Basin

TAC Meeting #1

June 5, 2007

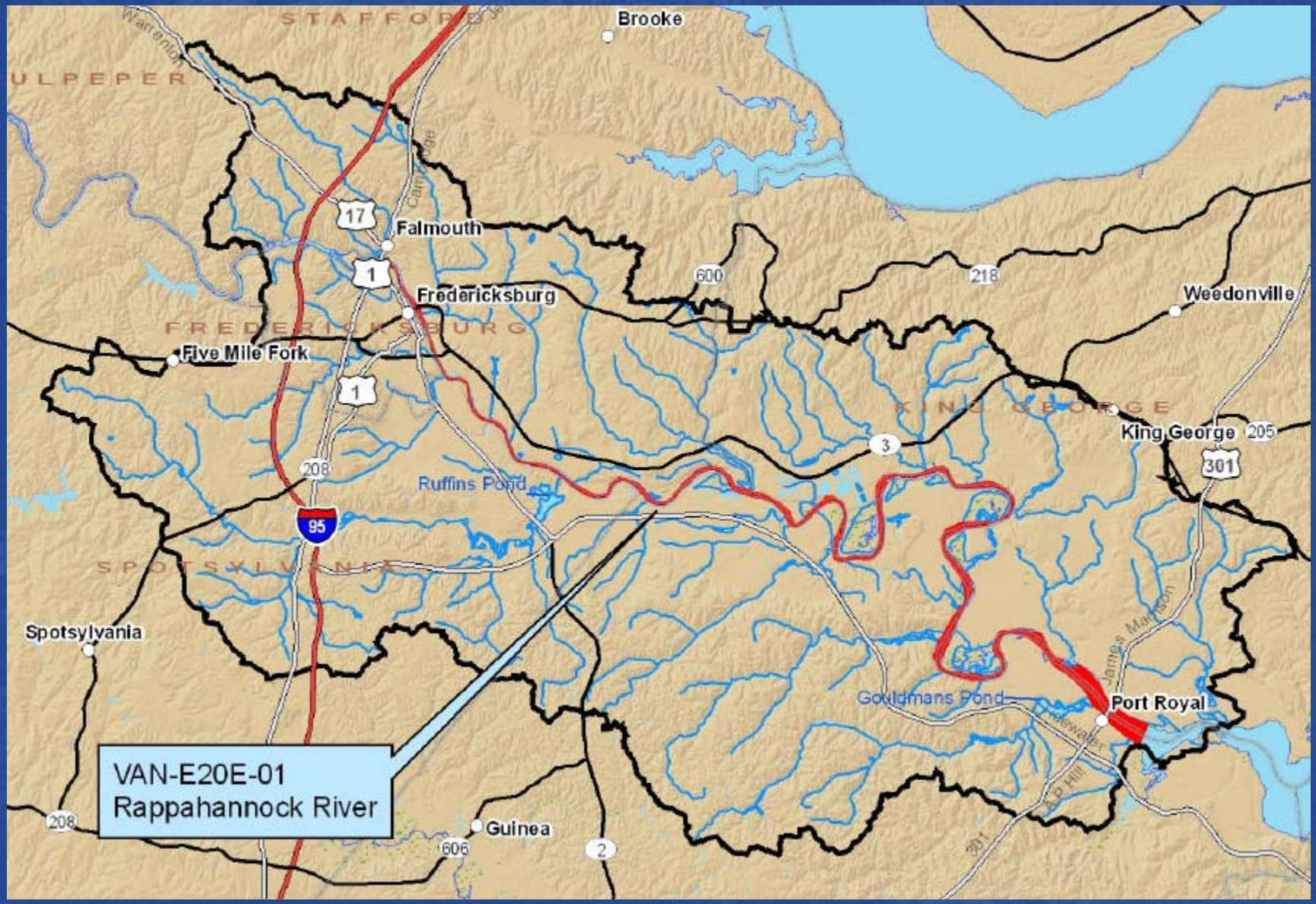
The University of Mary Washington

THE Louis Berger Group, INC.

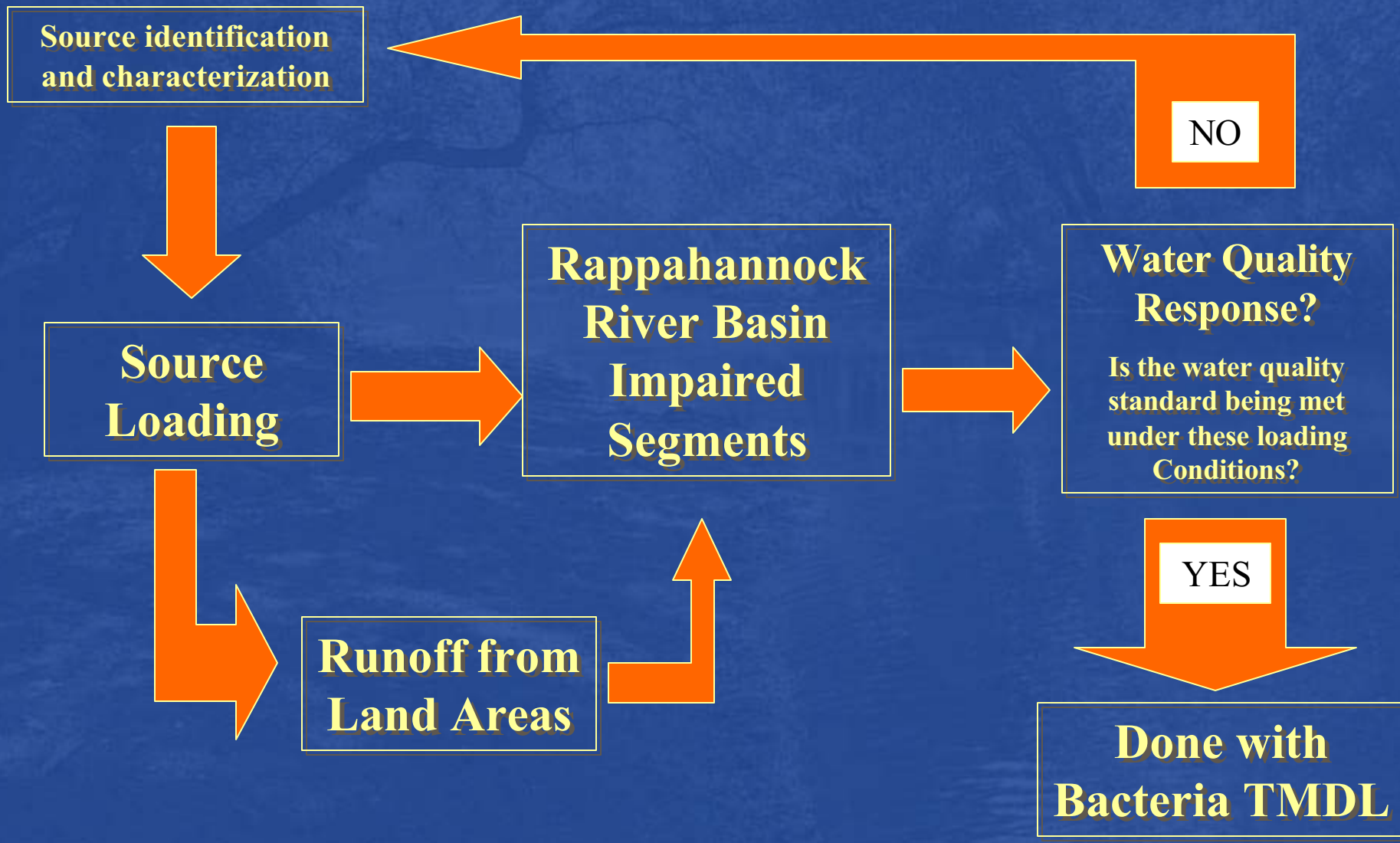
Objective:

- To present and review the steps and the data used in the development of bacteria TMDLs for listed segments in the Rappahannock River Basin.

Bacteria Impairment



Linking the Source to the Instream Water Quality

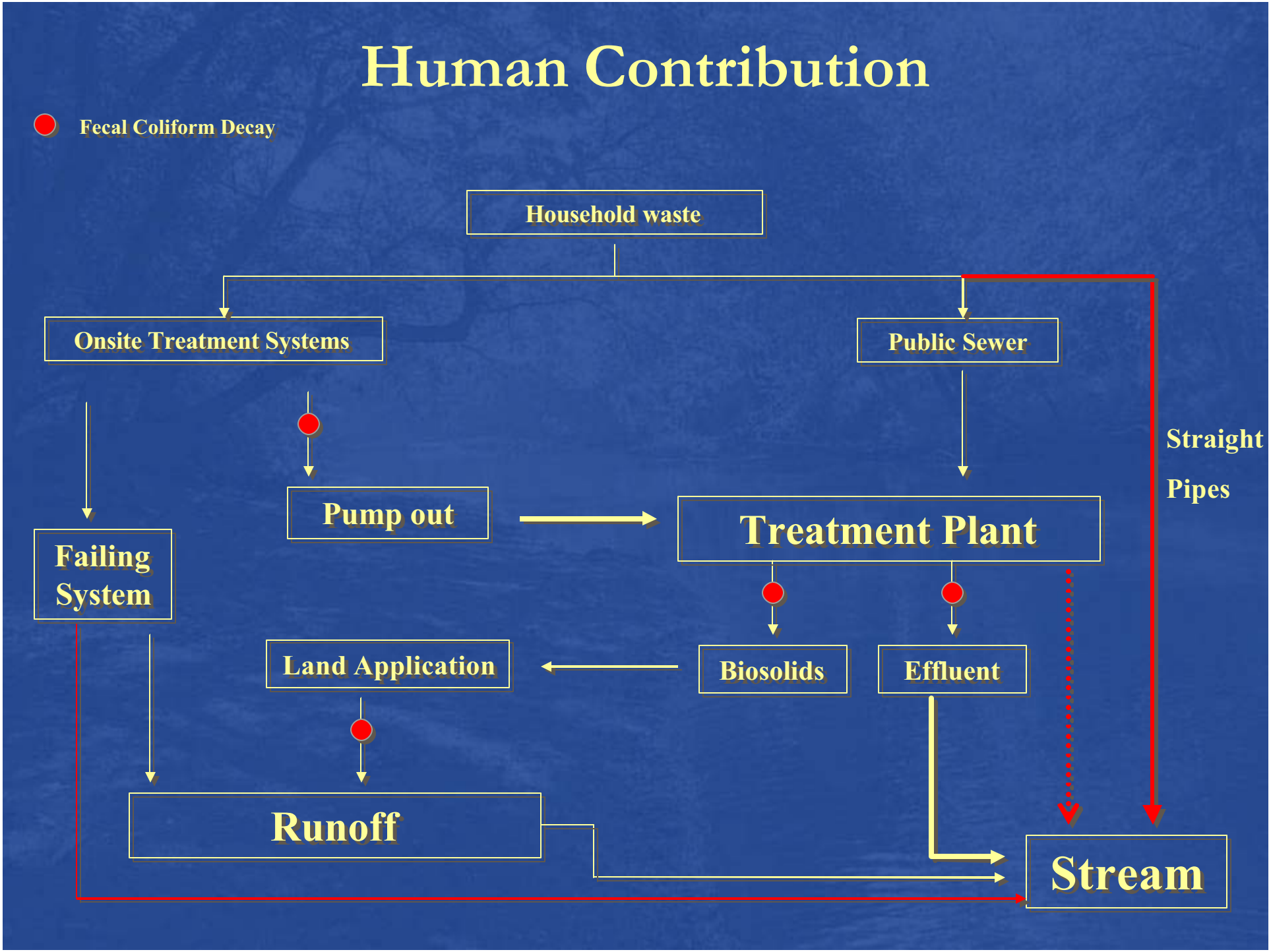


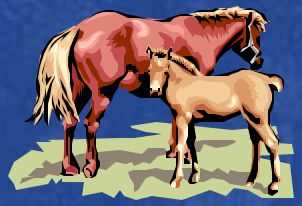
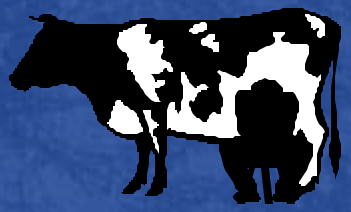
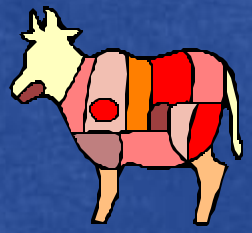
Bacteria Sources Assessment

Addresses the following issues related to bacteria production:

- **Bacteria loading from Human Sources**
  - Straight pipes
  - Septic systems
  - Biosolids
- **Bacteria loading from Livestock**
  - Livestock inventory
  - Livestock grazing and stream access
  - Confined animal facilities
  - Manure management
- **Bacteria loading from Wildlife**
  - Wildlife Inventories
- **Bacteria loading from Pets**
  - Pet Inventories
- **Best management practices (BMPs)**

Human Contribution



Livestock

Pasture

Confinement

Manure Storage

Manure Spreading

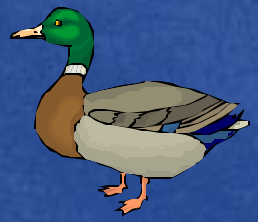
Pasture

Cropland

Runoff

Stream

Fecal Coliform Decay



Wildlife

Pasture

Cropland

Forest

Built-up area

Runoff

Stream

Fecal Coliform Decay

Pets: Dogs & Cats

Pasture

Cropland

Forest

Built-up area

Runoff

Stream

Fecal Coliform Decay

Source Loading Estimates

- Determine the daily fecal coliform production by source
- Estimate the size/number of each source
- Determine whether the source is
  - Direct Source
  - Indirect Source
- Calculate the load to each land use based on a daily schedule and for each source
- The sum of all the individual sources is the total load
- Source loading estimates used in HSPF model to simulate in-stream bacteria concentrations

Data Needs

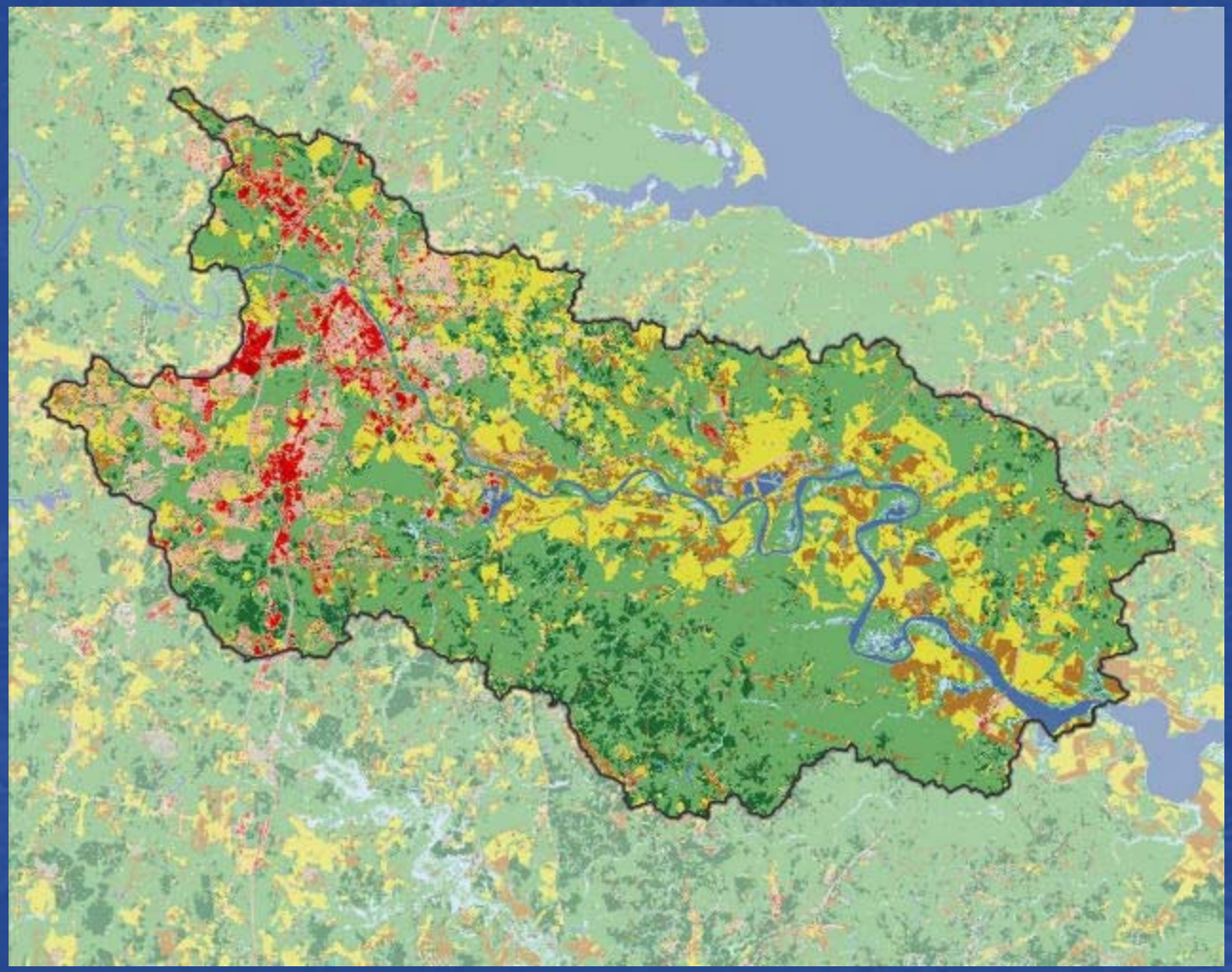
Data and Information Needs:

- Watershed physiographic data
- Hydrographic data
- Weather data
- Permitted point sources and direct discharges
  - Permit data and information
  - Discharge monitoring reports (DMR)
- MS4 permits and information
- Environmental monitoring data
- Stream flow data
- Bacteria sources assessment data

Watershed physiographic data:

Type of Information	Data Source	Obtained	Processed/ Analyzed	Notes
Stream network	*Reach File Version 3 (US EPA BASINS) National Hydrography Data (USGS)*	Yes	Yes	
Land Use/ Land Cover data	*National Land Cover Data (NLCD) 2001*	Yes	Yes	
Soils	*USDA State Soil Geographic Database (STATSGO)*	Yes	Yes	
Digital Elevation Model (DEM)	*BASINS*	Yes	Yes	10-meter DEM resolution

Rappahannock River Watershed Land Use



Dominate Land Use Types:

Forest: 53%

Agricultural: 29%

Bacteria Sources Assessment data:

Type of Information	Data Source	Obtained	Processed/ Analyzed
Population/ Household/ Septic System Estimates	*U.S. Census Bureau*	Yes	Yes
Livestock estimates/ agricultural practices	*USDA National Agricultural Statistics Service* *Soil and Water Conservation Districts* *Virginia Department of Health*	In Progress	In Progress
Wildlife estimates	*Virginia Department of Game and Inland Fisheries*	Yes	Yes
Pet Estimates	*U.S. Census Bureau* *National pet estimates per household*	Yes	Yes
Active and historical industrial site locations	*Virginia Department of Environmental Quality* *Local agencies and stakeholders*	Yes	Yes

Population Estimates and Sewage Disposal

Based on 2004 United States Census Data:

- **Population in the watershed is approximately 103,705 people**
- **There are approximately 32,488 households within the watershed**
  - 20,673 households on Public Sewer
  - 11,284 households on Septic Tank
  - 531 households on Other Means
- **Approximately 111 households in the watershed are on septic systems within 200 feet of a stream**
- **Assuming a septic system failure rate of 3%, 3 septic systems may be failing.**
- **Failed septic systems are considered straight pipes if located within 200 feet of a stream and are assumed to be directly discharging sewage into the stream**
- **Septic system design flow is 75 gal per person per day**

Livestock Estimates

Livestock Type	Caroline	King George	Spotsylvania	Stafford	Total
Beef cows	-	-	524	-	523
Milk cows	-	-	112	-	112
Hogs and pigs inventory	8	6	64	2	80
Sheep and lambs inventory	12	102	46	74	234
Chickens	37	103	234	268	642
Horses and ponies, inventory	117	448	265	481	1,311

Livestock numbers are based on the 2002 US Agricultural Census data and the horse numbers were based on the 2001 VA Agricultural Statistics Equine report.

Wildlife Estimates

Wildlife Animal	Caroline	King George	Spotsylvania	Stafford	Fredericksburg	Total
Deer	2,035	1,678	1,568	1,313	298	9,058
Raccoon	1,875	1,524	1,401	1,196	176	8,225
Muskrat	8,102	6,585	6,054	5,169	762	35,544
Beaver	884	718	660	564	83	3,877
Goose	173	143	133	112	25	771
Mallard	6	5	4	4	1	26
Wood duck	5	4	4	3	0	23
Wild Turkey	433	357	334	279	64	1,927

Estimates are based on NLCD 2001 land use data and distribution estimates from DGIF

Pet Estimates

Pet inventories based on:

- 0.543 Dogs per household*
- 0.598 Cats per household*

In the Rappahannock River Watershed there are approximately:

- 17,641 Dogs
- 19,266 Cats

*Source: American Veterinary Medical Association (AVMA) estimates

Rappahannock River Point Source Inventory

(VA Department of Environmental Quality)

Category	Permit Type	Count (Active or Application)
VPDES	Industrial	5
	Municipal	12
General Permits	Single Family Domestic Sewage	3
Total		20

Proposed Water Quality Model

CE-QUAL-W2*

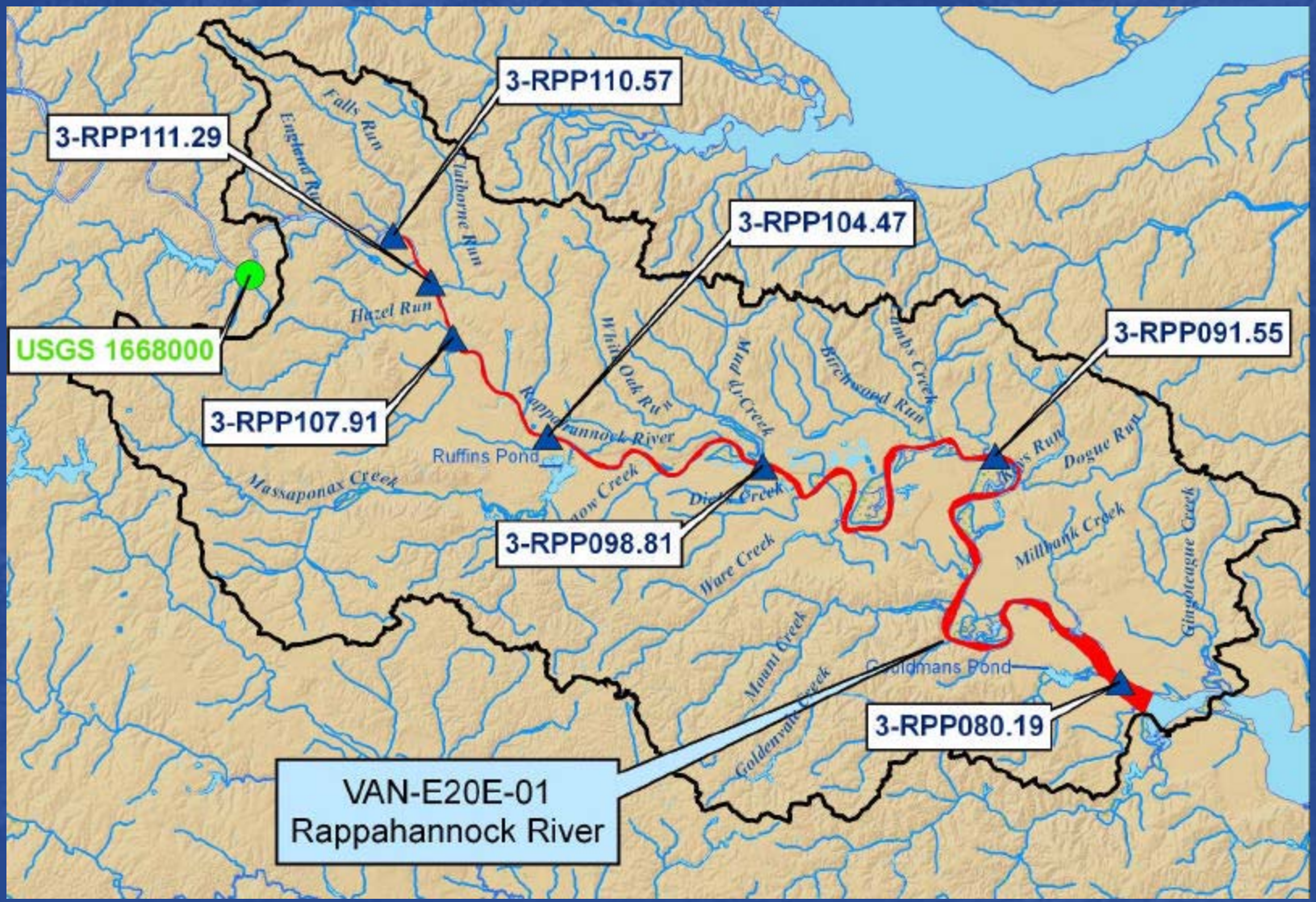
- Two-dimensional Hydrologic Model
  - May be applied to most water bodies in 1-D or laterally averaged 2-D (X/Z)
- Model Processes
  - Temperature, salinity, DO-carbon balance, nitrogen cycle, phosphorus cycle, phytoplankton, **bacteria**, first-order decay
- Outputs
  - Predicted water surface elevations, velocities, and temperatures
  - Conservative tracer, inorganic suspended solids, coliform bacteria, total dissolved solids, labile and refractory dissolved organic matter, algae, dissolved oxygen, ammonia-nitrogen, nitrate-nitrogen, phosphorus, total inorganic carbon, pH, carbonate, and total iron

*This is the proposed model to use, still needs EPA approval

Modeling the Impaired Segment

- **Impaired segment is 32 miles long**
  - Begins at Fall Line at Route 1 Bridge in Fredericksburg
  - Ends at confluence with Mill Creek, below Route 301 Bridge
- **Upstream Boundary Condition to be at USGS Station 01668000**
  - Area upstream of USGS station is primarily forested
  - Assume all flows upstream would be meeting water quality standards
  - Bacteria source reduction scenarios be developed and analyzed

Proposed Study Area



Next Steps

- **Collect additional available data**
- **Analyze data to investigate the bacteria impairments in the watershed**
- **Develop:**
  - bacteria source loading estimates
  - Final model/technical approach
  - modeling input parameters:
    - Hydrology and water quality
  - TMDL scenarios
- **Prepare Draft TMDL Report**

Local TMDL Contacts

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Reports/presentations available at:
www.deq.virginia.gov/tmdl/mtgppt.html

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